SCIENCE

VOL. 78 FRIDAY, OCTOBER 27, 1933 No. 2026

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

A CENTURY OF PROGRESS IN CHEMISTRY[1]

By Professor ARTHUR B. LAMB

DIRECTOR OF THE CHEMICAL LABORATORY OF HARVARD COLLEGE, PRESIDENT OF THE AMERICAN CHEMICAL SOCIETY

WHOEVER considers the history of the past 100 years can not but conclude that its outstanding feature has been the progress of mankind in science, that is, in the ordered knowledge of the world about us. In agreement with this, Mr. Dawes and his able co-workers have made the scientific sections of this exposition of unexampled completeness and excellence. Never have the achievements of science been so adequately portrayed at any exposition. Never anywhere has such a galaxy of scientific exhibits been gathered together, as is housed in this brilliant Hall of Science where we are now assembled.

Three thousand of the 18,000 members of our American Chemical Society have convened this week in Chicago from every corner of our country, to present and to discuss the most recent results of their researches. At this evening meeting of our Society, within the confines of the Century of Progress Exposition, it is eminently fitting that the contributions of chemistry to the advance of science during the past one hundred years should be set forth. It is, then, all but inevitable that I should address you this evening on

A CENTURY OF PROGRESS IN CHEMISTRY

In 1833 chemistry was, so to speak, still in her swaddling clothes. Less than fifty years had elapsed since Priestley and Scheele had discovered oxygen and chlorine; since Volta had discovered how to produce electricity by chemical means; since Lavoisier had elucidated the age-old problem of the nature of fire, and since Dalton had demonstrated the existence of atoms and had shown how their relative weights could be ascertained.

In 1833, chemistry was a small and compact science.

[1] A popular address (The President's Address) delivered at an evening meeting of the American Chemical Society at the Century of Progress Exposition in Chicago, September 14, 1933.

It was concerned chiefly with mineral substances and with a number of so-called organic substances derived from vegetable and animal sources, only one of which, namely urea, had been made in the laboratory from inorganic, lifeless materials. A chemist of that period could be expected to be well informed about every branch of his science. Indeed, Berzelius, each year in his "Annual Reports," discussed with intimate knowledge and with authority every important chemical contribution of the past twelve months.

During the succeeding century, chemistry has changed from a single science to a collection of sciences, no one of which can be fully mastered by a single intellect. The sciences of thermochemistry, electrochemistry, photochemistry, radio chemistry, chemical dynamics, chemical statics and biochemistry have come into being. They are almost exclusively the products of the past one hundred years.

It will be impossible for me to give even an outline of these vast developments. I shall, therefore, only undertake to describe, in language which I trust will be sufficiently free from technicalities so that people who are not chemists can understand, a few typical and significant chemical achievements of the past one hundred years.

The most patent of these achievements are those which minister directly to the material welfare of mankind; better and cheaper supplies of old and known materials, or wholly new and superior materials. I shall speak of these achievements first, and specifically of new inorganic substances.

Since 1833, forty new elements have been recognized, most of them present in only minute amounts on the earth. All but three of these new elements have been isolated and studied. I shall mention four of them specifically.

First, helium, discovered in 1893 by Ramsay as an infinitesimal constituent of the atmosphere. Excessively rare on our earth, it is a major constituent of innumerable giant stars. Although its only important commercial use is for the inflation of airships—where its non-inflammability coupled with its lightness makes it invaluable—it has been of the greatest importance in theoretical chemistry.

Second, neon, also discovered by Ramsay, resembles helium in many respects and is even more rare. It finds its chief commercial application as a gaseous filling for the brilliant glow lamps that enliven our thoroughfares and adorn the towers of the Hall of Science.

Third, radium, that marvelous element discovered by Madame Curie in 1898, which has been of incalculable value to the physician and, as we shall shortly see, like a magic wand, has unlocked the secrets of the structure of matter.

Fourth, heavy hydrogen, discovered about a year ago by Urey, Brickwedde and Murphy. This variety of hydrogen is present in minute amounts along with ordinary hydrogen, in water, petroleum and presumably in the myriad other compounds of this element. Washburn showed how to concentrate it and Lewis has prepared pure samples of it and has shown, for instance, that water made from oxygen and this new variety of hydrogen has very different physiological properties from ordinary water.

The discovery of these four elements alone would have been sufficient to make any century illustrious!

Of even greater practical importance are the striking improvements that have been wrought since 1833 in the preparation of many common substances. I shall again cite four examples:

First, iron and steel. The small blast furnaces of 1833 have grown into the huge structures of to-day nearly one hundred feet high, turning out 600 tons of pig iron a day. The old process of making steel by prolonged heating of wrought iron in contact with charcoal has been replaced, for instance, by the Kelly-Bessemer process, where sixteen tons of pig iron is converted into steel in almost as many minutes.

In 1833 American steel sold at wholesale in New York for $180 a ton on the currency basis of 1926. To-day finished steel on this same basis sells for $28.00 a ton. I need not tell you that our whole industrial civilization rests upon the abundance and cheapness of this indispensable metal!

Aluminum is my second example. In 1833 this metal was a museum rarity, for only a few grams of it had ever been made. In 1854 it sold for $100 a pound. In 1886 Charles Hall, then a student at Oberlin College, working with a make-shift apparatus in the obscurity of a garret, discovered how to prepare aluminum easily and cheaply by an electrolytic method. Independently Héroult in France discovered the same method at almost the same time. This method, in its essentials, is still in use to-day, producing huge amounts of the metal selling at about 23 cents a pound.

My third example is sodium carbonate. This substance, often called soda, has been known since prehistoric times and has a thousand uses in the industries and the arts. Chief of these is in the manufacture of glass and of soap. In 1833 soda had long been made from certain plants that grow in marshy land near the sea. They were burned, their ashes leached with water and the liquors evaporated. To-day sodium carbonate is made by the Solvay process on a huge scale from limestone and coal. It is of remarkable purity and sells for about one-tenth of its price in 1833.

My final example is ammonia. In 1833 this gas

was obtained almost exclusively as a by-product of the distillation of coal. It has long been used in great quantities in the manufacture of ammonium sulfate, one of the two important nitrogenous fertilizers. The other important nitrogenous fertilizer is sodium nitrate, obtained from natural deposits in Chile.

In 1898, Crookes pointed out that the supply of ammonia and hence of ammonium sulfate was relatively limited, and that at current rates of consumption the Chilean nitrate deposits would be exhausted in a few decades. As a consequence, chemists eagerly sought ways of making nitrogenous fertilizers out of the limitless supply of inert nitrogen in our atmosphere. Haber, in 1905, by the application of the principles of physical chemistry, succeeded in demonstrating the possibility of forcing the nitrogen of the air to combine directly with hydrogen to form ammonia. Shortly afterward Bosch developed the active and robust catalysts which were required to make this process a commercial success.

Never was a discovery more timely! The world war was just breaking and Germany was soon shut off from the supply of Chilean nitrates. The synthetic ammonia factories were rushed to completion and greatly enlarged. The ammonia there made was easily converted into the nitric acid and the nitrates required in the manufacture of explosives. Thus throughout the war, Germany was able to keep her armies adequately supplied with ammunition.

Since the war there have been many further improvements in this process and it is now practised on a large scale in several countries. Nitric acid and nitrates can be made so cheaply from this ammonia that they compete successfully in the world markets with the Chilean supply. Clearly the threat of a nitrogen famine no longer exists.

More important, however, than the cheap and abundant ammonia which this process now provides are the contributions it has made to the technology of high pressure and of large scale catalysis. It has opened up a new realm of chemical manufacture of immense promise for the future.

I wish now to turn to the material achievements of organic chemistry; to the improvements in the manufacture of already known, and to the discovery of new, organic substances.

Since 1833 the refining of sugar has been highly perfected, so that commercial sugar is now of astonishing purity and cheapness. Petroleum has been refined and separated into hundreds of products indispensable to our modern life. In particular, the manufacture of gasoline and of lubricating oils has become a great industry. Even the synthetic manufacture of these substances from coal has been accomplished and, in favorable localities, put into commercial operation. The refining and hardening of edible oils and fats is another organic chemical industry that has originated during the past century and become of great economic importance.

More impressive than all these developments are the myriads of new substances that the organic chemist has fashioned in his laboratory. As contrasted with the relatively few organic substances known in 1833, it is estimated that there are now more than 300,000 of these new substances; substances which, so far as we know, never before existed in the world!

Almost countless in number, these substances are almost endless in their variety. They comprise dyes, perfumes, flavors, foods, fabrics, resins, plastics, explosives and innumerable drugs, to mention only a few of the larger classes.

I can speak in greater detail of but two of these classes. First, dyes. In 1833 dyes were nearly all extracted from plants and trees. The two most important, madder and indigo, were produced synthetically in 1868 and 1889, respectively, and are now exclusively manufactured in this way. More important, Perkin in 1856 discovered the first aniline dye which he christened "mauve." Thousands of such dyes derived from aniline or related substances have now been made. They are almost infinite in the variety of their colors. The best of them are more brilliant than the natural dyes of similar hues and are much more permanent.

Second, medicines. Although only a small fraction of the 300,000 organic substances known have been tested from this point of view, thousands of them have been found to possess valuable medicinal properties: antiseptics, stimulants, sedatives, hypnotics, anesthetics. Perhaps most interesting of all are the specific drugs that in a few instances have been developed to combat definite diseases. In the search for such a specific a likely organic substance is selected as a starting material, and its molecule is systematically altered by the removal and introduction of different atoms, until a substance is obtained that is highly and peculiarly poisonous to the particular bacteria or other organisms responsible for the disease. The first great success of this kind, achieved after years of research, was "salvarsan."

Another was "Bayer 205," a specific for African sleeping-sickness. Such purposeful and systematic search for definite specifics holds great promise for the future of medicine.

So much for the material contributions that chemistry has made, during the past one hundred years, to the welfare of mankind. Without them our present civilization would be impossible. They impinge

upon mankind in every corner of his world and at every moment of his existence. They have profoundly affected most of his manifold fabrications; his houses, his means of transportation, his implements, his weapons, his medicines, the very clothes he wears and the food he eats!

I now turn to what is still more significant, namely, the advances in chemical knowledge during this period. I shall discuss, as typical of these advances, the progress that has been made in our knowledge of the structure of matter.

In 1833 Dalton had already demonstrated that matter was composed of atoms, but the greatest confusion still prevailed as to the relative weights of the atoms and as to the formulas of the compounds they formed. Actually, Avogadro in 1811 had already shown how the relative weights of the smallest particles or molecules of gases could be ascertained, and how by assuming that the molecules of the common gaseous elements contained two atoms, a consistent set of formulas for all gaseous substances could be established. Unfortunately this discovery remained either neglected or unappreciated for nearly forty years. In 1858 Cannizzaro called attention to this work of his countryman, and its importance was promptly recognized. Like a ray of sunshine, it dispelled the uncertainties and confusion in Dalton's atomic theory. In 1874 the correctness of Avogadro's fundamental assumption of the doubled formula for the common elementary gases was established by independent and indubitable evidence.

Meanwhile, the organic chemist, in spite of the handicap of uncertain atomic and molecular weights, had made important advances in ascertaining the structure of his substances.

His problem was, however, a most difficult one. The formulas of organic substances were usually very complicated, even though they consisted of remarkably few elements, namely, carbon, hydrogen, and in addition usually oxygen or nitrogen or both. During the first twenty years after 1833 little progress was made in unraveling their structure, although certain characteristic groups of atoms were recognized as occurring in many different substances and some classification of organic substances was achieved. Indeed, the perplexity increased rather than decreased during this interval, for chemists were already learning how to convert one original organic substance into dozens of new ones. As a consequence, the number and variety of organic substances multiplied prodigiously and organic chemistry was threatened with asphyxiation in a deluge of her own progeny.

Most perplexing of all were the numerous pairs and groups of organic substances, called isomers, such as the silver fulminate of Liebig and the silver cyanate of Woehler, which, though quite different in their properties, nevertheless were identical in their composition; that is, their molecules contained exactly the same number of atoms of the very same elements.

To the chemist of the 50's these multitudinous organic substances with complicated and at times indistinguishable formulas presented a puzzling, indeed a bewildering array!

Then in 1852, within a few months of each other, Frankland in England, Couper in Scotland, and Kekulé in Germany found the key to this locked door. This key was the idea of valency, or the number of other atoms that any one atom can attach to itself. Thus the hydrogen atom which can attach to itself but a single other atom, has a valence of one. It has, speaking symbolically, but a single hand with which it can grasp the hand of some other atom. The oxygen atom has a valence of two, the carbon atom a valence of four; that is, the oxygen atom has two hands, the carbon atom four hands with which they can grasp the hands of other atoms. Two carbon atoms can unite by each grasping a hand of the other, leaving each atom with three other hands with which it can grasp hydrogen, oxygen, additional carbon atoms, or indeed almost any other atoms it may desire.

Adhering to this idea of fixed valencies, atomic structures could be pictured which not only corresponded exactly with the numerical formulas of organic compounds but also with the numerical formulas of the groups of atoms whose presence in the compounds had already been established. The key fitted.

The diagrams which the organic chemist could now draw of his innumerable substances showed that they usually consisted of chains of carbon atoms, where each carbon atom grasped the hand of a neighboring carbon atom on his left and right. These chains were like the human chains used to rescue drowning people, except that each carbon atom had two extra hands, one in front and one behind with which it grasped other atoms, usually of hydrogen, oxygen or nitrogen.

"Very pretty," you say, "but how about isomers, those different substances with the same numerical formula?" The answer is simple and illuminating. First, in thousands of cases where the valencies permit but a single arrangement, only a single substance of this formula is known; there are no isomers. Second, in thousands of cases where the valencies do permit a certain number of different arrangements of the atoms, and therefore indicate the existence of that number of isomers, chemists have been able to prepare exactly that number of isomers and no more. In other words, the facts of isomerism, instead of presenting a difficulty, are an

emphatic confirmation of the structural formulas based on valency.

A few undeniable exceptions to these generalizations still remained. And this brings me to the final step which organic chemists took in deciphering the structure of molecules.

Pasteur, in 1860, had found pairs of substances with identical structural formulas, that is, substances whose molecules contained exactly the same atoms apparently arranged in exactly the same way which, although alike in other respects, nevertheless behaved differently toward polarized light. One member of each pair rotated the plane of polarized light to the right, the other to the left. Here was a more subtle and elusive kind of isomerism not explicable by the simple principles of valence.

In 1874 Van't Hoff and LeBel both pointed out that this isomerism only occurred when there was in the molecule an atom of carbon each of whose four valencies held a different atom or group of atoms. They pointed out that in such an asymmetric assembly of atoms there can be both a right-handed and a left-handed arrangement of the four different atoms about the central carbon atom and that two such isomers should rotate the plane of polarized light in opposite directions.

This explanation has been confirmed by all subsequent investigation and indeed has been extended to cover asymmetric atoms of other elements. Thus even this delicate type of isomerism found an explanation on the basis of structure.

Van't Hoff went still further. He showed that these phenomena indicated that the four valencies of the carbon atom were fixed at the corners of a regular tetrahedron whose center was the center of the carbon atom. In other words, carrying our anthropomorphic analogy a little farther, and considering the valencies of atoms to be represented by legs as well as by arms, the carbon atom can be pictured as a man standing with his legs spread widely apart, his shoulders turned squarely to one side and his arms pointing diagonally upward, one arm toward the front and one toward the rear. A man who achieved this somewhat trying posture by turning toward the right would represent one isomer; he who did so by turning to the left would represent the other isomer.

Subsequent investigation has confirmed this tetrahedral conception of the carbon atom, and recent measurements of the electromagnetic properties of carbon compounds have established it beyond question.

Chemical molecules can no longer be thought of as arrangements of atoms in a single plane—they are structures in three-dimensional space.

Thus the organic chemist by extraordinary industry and acumen has deduced the number, arrangement and geometry of the atoms even in very complicated organic molecules. He makes diagrams of these atomic structures just as an engineer makes blueprints of his buildings. He sees with his mind objects a thousand times too small for his eye to see, even under the most powerful microscope.

Meanwhile, an attack was launched from a wholly different quarter that was to lead to a knowledge of the structure of the very atoms themselves. Newlands and others about the middle of the past century observed that the properties of the elements were recurrent; that is, if the then known chemical elements were arranged in the ascending order of their atomic weights, nearly every eighth element exhibited marked similarities. That is, the eighth element resembled the first, the ninth the second, etc. However, there were so many exceptions that this observation was hardly given serious consideration by other chemists. In 1869 Mendeléeff independently made the same observation as Newlands and further showed that by leaving a number of blank spaces at appropriate points in the series of elements, the regularity became surprisingly exact. He prophesied that new elements would be found whose atomic weights would correspond to these blank spaces and whose properties would be similar in each instance to the eighth preceding and the eighth succeeding element. He was so confident of the validity of this relationship that he predicted minutely and numerically the properties of a number of these as yet undiscovered elements. Within ten years half a dozen new elements were discovered. They not only fitted neatly into the blank spaces, but their properties were precisely what Mendeléeff had foretold!

All the thirty additional elements since discovered have fitted equally well into the remaining blank spaces. There can be no question as to the reality of this periodicity in the properties of the elements.

Moreover, it was certain that this regularity reflected some genetic relationship among the atoms—a veritable "family tree" of the elements. The atoms could not be inchoate particles of fortuitous, unrelated, different kinds of matter; they must be built up of a more fundamental unit or units of matter according to a scheme of architecture which found its reflection in the periodic properties of the elements.

This inference was confirmed by a rapid succession of discoveries. In 1897 J. J. Thomson, from studies of the passage of electricity through gases, showed that the unit charge of electricity, which Faraday in 1833 had found chemical atoms to carry in the process of electrolysis, was capable of free existence, and that it behaved as an atom of negative electricity with a mass only about 1/2000 of that of the hydrogen atom,

the lightest of the chemical atoms. These atoms of negative electricity were called "electrons."

The very next year Madame Curie made the momentous discovery of radium. Rutherford and others demonstrated that a minute fraction of the atoms of this remarkable element were continually exploding with astounding results. Rays were emitted similar to x-rays; atoms of helium charged with positive electricity were expelled from the exploding atoms at speeds of thousands of miles per second, while electrons were shot out at speeds ten times as great, comparable with the velocity of light. In addition, atoms of lead were found among the debris of these atomic cataclysms. Soon it was found that other chemical elements exhibited this same instability, though in a less degree than radium.

Here was conclusive proof that the atoms of our chemical elements are not simple and inalterable particles, but are complex structures made up of simpler and smaller units and subject to disintegration.

The most important of the units, or building stones of the atoms, are the electron and the proton, the proton being the positively charged nucleus of the hydrogen atom, that is the hydrogen atom minus its single electron. The positron, an almost weightless unit of positive electricity, and the neutron, a coalesced electron and proton, have been discovered recently but their importance in the construction of atoms is still uncertain.

The architecture of most of the atoms, and particularly of the larger atoms, is still imperfectly understood. The architecture of the simplest of the atoms, namely hydrogen and helium, is somewhat better known. In the hydrogen atom the extremely minute proton comprising most of the mass of the atom occupies a central position and the electron appears to revolve rapidly about it at a relatively great distance. The properties of hydrogen, such for instance as the wave lengths of the light it emits under different conditions, can be calculated on the basis of this structure with truly astronomical precision.

The term "astronomical" is appropriate, for actually when the distance between proton and electron is compared with the diameters of these units themselves, the atom is seen to resemble the solar system where the distances between the planets and the sun are very great in comparison with their diameters.

As regards the larger atoms, it is known that their mass, like that of hydrogen, is all concentrated in a minute central nucleus. This nucleus is made up apparently of protons and about half of all the electrons in the atom. The remainder of the electrons appear to circulate about this nucleus, their orbits lying in a series of concentric shells comparable to the successive layers of an onion.

As soon as these discoveries as to the structure of atoms had been made, chemists and physicists tried to break up the ordinary, stable chemical atoms, or to make them explode as radium atoms do on their own initiative. At first, all these attempts were in vain. Finally, by bombarding them with the positively charged helium atoms shot out of exploding radium atoms, a number of these stable atoms were shattered and helium and hydrogen atoms were found among the debris. Similarly, by bombarding, for instance, lithium atoms with protons shot out of an electric cannon, atoms of helium were produced.

Thus, on a small scale and at great expense the goal of thousands of years of human effort has been reached—the transmutation of the elements! To be sure the particular dream of the alchemist, the transformation of base metals into gold, is still unrealized, but this no longer appears impossible or, thinking in centuries, unlikely.

Another possibility which these discoveries have afforded is even more alluring. The helium atoms obtained from the bombardment of lithium and other atoms with protons are endowed with enormous energy, thousands of times that of the bombarding particles. Here is a source of energy which, if it could be practically and efficiently utilized, would surpass by a thousand times the energy obtainable from all the coal in the world!

There is one final observation that I should like to make. These contributions of chemistry during the past one hundred years that I have recited, these better and cheaper materials, this wealth of wonderful new substances, this deeper understanding of matter, profoundly affect the heart and the soul of man. As he contemplates these new disclosures of the extent, the intricacy, the wonder and the beauty of this, his universe, he can but exult at the glorious opportunity of mankind. As he considers these innumerable intellectual achievements, these repeated decipherings of an all but inscrutable scroll, he can but thrill with pride at the fertility and power of the human intellect.

Ladies and Gentlemen, except in the inconceivable event of a complete eclipse of our civilization, these contributions of the past one hundred years to human welfare are lasting. Material wealth may come and go, governments may rise and fall, systems of human society may evolve and disappear, but these additions to human knowledge that I have described this evening, this "Century of Progress in Chemistry" is a permanent asset of the race!

OBITUARY

CLEMENT DEXTER CHILD

DR. CLEMENT DEXTER CHILD, professor of physics at Colgate University, died on July 15 at the Rochester Memorial Hospital after a serious operation. Born in Madison, Ohio, in 1868, Dr. Child received the A.B. degree from the University of Rochester in 1890. After two years of high-school teaching he began graduate study, and later became instructor in physics, at Cornell University, where he received the degree of Ph.D. in 1897. The next year was spent in experimental work at the University of Berlin. In 1898 he became head of the department of physics at Colgate University and held this position until his death. While on leave of absence from Colgate in 1908 he spent several months in experimental research at the Cavendish Laboratory.

Dr. Child's interest and activity in research were shown even at the very beginning of his graduate study; he had published three papers before receiving his degree. And, in spite of the demands of a heavy teaching load and the responsibility of his position as department head, he continued active in experimental research up to the time of his death. His experimental work, especially in the early years, dealt with a wide range of subjects. There were, for example, papers on the measurement of thermal conductivity, on detectors for electric waves and on the discharge of electrified bodies by x-rays. Later, his interest focused rather sharply on problems connected with electrical conduction in gases, and it is in this field that his most important work was done. His book, "The Electric Arc," published in 1913, deals in considerable detail with this particular type of electrical discharge in gases and is a recognized authority in its field.

The greater part of Dr. Child's scientific work was pioneer work, in which his experiments were planned to throw light on some phase of a new phenomenon and where his results and his interpretation of them have contributed in no small degree to scientific progress. His investigation, for example, of the discharge of electrified bodies by x-rays was undertaken at a time when very little was known either of x-rays or their discharging action. In reading his papers on this subject now, with knowledge of the developments that have come since, it is interesting to note the accuracy of his observations and the correctness of his interpretations. Perhaps the most striking instance of this sort is in connection with his important work on space charge effects. His attention seems to have been first attracted to space charge phenomena in 1903; and in 1911, when he published the derivation of the law that is usually referred to as the "Child Law," his explanation of these effects was so clear and accurate that it might be used without change to-day. A number of important practical devices involving space charge effects have their scientific foundation in Dr. Child's 1911 paper.

Dr. Child's teaching was characterized by soundness and thoroughness. The students in his classes did not find themselves under a drill master but in contact with a kindly, sympathetic man, thoroughly imbued with the scientific spirit and giving an example of intellectual honesty in all his dealings. Modest and unassuming, helpful and sympathetic, yet ready to fight dishonesty or wrong, he commanded the respect of all his associates and the sincere affection of his friends. Many of his students have gone on to successful careers in physics; but even those who have entirely forgotten the subject-matter of his classes have received permanent benefit from his example.

ERNEST MERRITT

PAUL EHRENFEST

THE sudden news of the death of Professor Paul Ehrenfest, of the University of Leiden, has given his many friends all over the world a great shock and intense sorrow. It is difficult, with the pain lying as a stone on our hearts, to try to enumerate the special virtues of his lovable character and his great mind. Perhaps they were his honesty and his strong and humble desire to help where he could. Everybody could count on his help, and it was especially for his students, not restricted to physics alone. Well known was his active and passive interest in music, with his great admiration for Bach, which started in his early childhood.

In physics, the science which fascinated him from his youth, his astonishingly clear mind enabled him to reduce all problems to their essential points ("der springende Punkt" or "Patentanspruch" as he used to say). It was this power which was the main source of inspiration for his pupils and for all who had the privilege of coming in contact with him. This and his friendliness and humility made the colloquium in Leiden such a great success, made it a gathering place for physicists of all nations. Ehrenfest was, therefore, always invited to all the important physics meetings and congresses. In this way, even more than by his own published articles, he has exerted a considerable influence on the development of modern theoretical physics.

All who were privileged to work with him will always remember his "Socratic" discussions and how helpful they were in clarifying their ideas. He disliked all unnecessary learnedness and vagueness, and knew always by means of his characteristic terminol-

ogy and by simple models how to make his subject as "anschaulich" as possible. With his interest in pedagogical problems, he was strongly attracted to youthful beginners, to whom he never failed to give encouragement and with whom he shared his great enthusiasm, so essential for their further progress and development.

Paul Ehrenfest was born in Vienna in 1880, where he became the outstanding pupil of Ludwig Boltzmann. He clarified the curious difficulties and paradoxes which still remained in Boltzmann's life work, the kinetic interpretation of the second law of thermodynamics. In their famous article in the *Enz. der Math. Wiss.*, Vol. IV (1911), P. and T. Ehrenfest showed conclusively that there were no inner contradictions in the work of Boltzmann. His interest in statistical theory kept him in close contact with the development of the quantum theory; Ehrenfest's "adiabatic hypothesis" was an essential step forward. Paul Ehrenfest worked in Göttingen and spent also a considerable time in Russia. In 1912 he was invited by the late H. A. Lorentz to succeed him in the chair of theoretical physics at the University of Leiden. He visited the United States in 1924 and in 1930, when he lectured at Pasadena and in the Theoretical Symposium at the University of Michigan.

The general upheaval, political and economic, of post-war Europe and especially the recent tragic fate of many of his dearest friends in Germany, depressed him deeply. Ehrenfest's death, lamented by all who knew him, is an irreparable loss to his pupils.

G. E. UHLENBECK
S. GOUDSMIT
G. H. DIEKE

F. FÜLLEBORN

TROPICAL medicine and parasitology has suffered a great loss in the death, on September 9, of Geh. Medizinalrat Professor Dr. Friedrich Fülleborn. When the Institut für Schiffs- und Tropenkrankheiten was founded at Hamburg in 1900, he was called to head the department of tropical medicine, and on the retirement of Dr. Bernhard Nocht in 1930 he became director of the institute. Thirty years of achievement as physician, teacher and investigator led naturally to the position of administrative leadership, and he was active until stricken by a fatal heart attack.

During his student days he came under the influence of Rudolph Leuckart at Leipzig and acquired an interest in the biology of animal parasites and their pathological effects. This early interest became the directive influence of his mature years. Over a hundred published researches, especially in the field of helminthology, bear witness to a life of tireless and brilliant investigation. An outstanding figure in the field of tropical medicine, he had received many honors in all parts of the world and was an honorary foreign member of the American Society of Parasitologists.

But for those who knew him personally, and I was privileged to spend the year 1931–1932 in his laboratories, it was his nobility of character and his qualities of mind and heart that endeared him to his associates. A truly great man has left us.

H. W. STUNKARD

RECENT DEATHS

DR. EDWIN SCHOFIELD CRAWLEY, professor emeritus of mathematics at the University of Pennsylvania, died on October 18. He was seventy-one years old.

DR. JAMES ABRAHAM FARIS, senior pathologist, in charge of cereal smut investigations, Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, died on September 24 at Washington, D. C., at the age of forty-three years.

DR. CHARLES C. PLITT, professor of botany at the University of Maryland School of Pharmacy, known for his microscopic investigation of drugs and the taxonomy of lichens, died at his home on October 13, at the age of sixty-four years.

Nature reports the death of Professor Leonard J. Rogers, formerly professor of mathematics in the University of Leeds, on September 12, aged seventy-one years; of G. M. Thomson, founder of the Dunedin Technical College and the Portobello Marine Biological Station, an authority on the natural history of New Zealand, aged eighty-four years, and of Lieutenant-Colonel R. H. Rowe, commissioner of lands, Nigeria, known for his work on the topographical and trigonometrical survey of Nigeria, on September 6, aged fifty years.

SCIENTIFIC EVENTS

THE TERCENTENARY OF THE ASTRONOMICAL OBSERVATORY AT LEIDEN

THE tercentenary of the Leiden Astronomical Observatory, the oldest in Europe, was celebrated on October 6 at Leiden University. A correspondent of the London *Times* reports that among those who were present at the ceremonies were Professor Stratton, England; Professor Silva, Italy; Dr. Bergstrand, Scandinavia; Dr. van Oort, United States, and Professor E. Bianchi, of the International Astronomical Union.

The Rector Magnificus, Professor D. van Blom, de-

livered the opening speech, after which the director, Professor Willem de Sitter, sketched the history of the observatory, which was founded by Golius, the pupil of Snellius, in 1633 and refounded in its second period in 1851 by Kaiser when astronomy was reorganized on modern lines.

In an interview Professor de Sitter, who has now been director for twenty-five years, said that an agreement was made by the Leiden Observatory in 1923 with the Johannesburg Observatory by which a member of the Leiden Institute has since been working in Johannesburg. Three years ago the Rockefeller Foundation made a gift of $100,000, a portion of which was allotted for the purchase of a large modern spectroscope to be made in England. A second, smaller spectroscope is being built in Holland and both instruments will be ready and delivered next year.

The teaching of astronomy at Leiden dates from soon after the foundation of the university in 1575, but it was not until 1633 that, thanks largely to the efforts of Dr. Rudolf Snellius, the famous tutor of Prince Maurice of Orange and first professor of mathematics at Leiden, the university authorities recognized the claims of the new science and built the first observatory—a wooden tower on the roof of the university buildings.

Snellius himself had not lived to see it—he died in 1629—but it was his large wooden quadrant which was placed, first in the open air on the roof of the tower, later in a special room with a sliding roof. The first apparatus was scanty and primitive—a couple of globes out of the library and half a dozen miscellaneous instruments. A wooden quadrant with which the first observations of any importance were made in 1658 is still preserved at the observatory.

During the seventeenth century the observatory gradually developed in size and importance, and in 1689 moved into a new building specially constructed to house a copper sextant which cost the authorities over 1,000 guilders.

The first professor of astronomy, Willem 's Gravesande, was appointed in 1717.

NEW GERMAN GEOGRAPHICAL PUBLICATIONS

The Geographical Journal notes that two new German series have commenced publication recently. Both are devoted largely to the geographical aspects of settlement in relation to environment. The Geographical Institute of Berlin University is issuing *Berliner Geographische Arbeiten*. The first, by W. Hartke, deals with changes in the human geography of northeast France brought about by the war devastation and reconstruction. His general conclusion is that all recent developments in agriculture, economic life and distribution of population were foreshadowed in pre-war days, though their quickening may be attributed in most cases to the war. Areas of heavy depopulation are markedly associated with those areas in which fighting was most severe. Urbanized areas show great increases, largely owing to the universal drift to the towns—in contrast to the rural districts, some of which showed a 30–40 per cent. decrease between 1911 and 1926. The structure of the population also shows changes, as the influx from the rest of France and from abroad has been large. In the second part, H. Winz attempts to draw a complete picture of the cultural geography of the Upper Inn valley from personal observation and research in archives. Most of his space is given to the development of settlement from prehistoric times, leading up to a consideration of the present distribution. Outstanding features, which react upon each other, are the reversion of tillage to meadow-land and depopulation. In some districts one quarter of the land went out of cultivation between 1860 and 1928, owing, in some instances, to the advent of alternative sources of livelihood.

The second series, published by the Geographical Institute at the University of Kiel, begins with a monograph by H. Wenzel on the basin of Ak Shehr. This area, in the southwest of the high interior steppe lands of Anatolia, depends for its prosperity upon the streams and springs fed by the northeastern slopes of the Sultan Dagh range. The author therefore pays special attention to the hydrology and irrigation system. The district of Ak Shehr, according to the 1927 census, has a population density above the average for inner Anatolia, slightly more than 20 per square km. Actually, about 62 per cent. is concentrated in the west, around the town. There are three elements: "Turks" in a wide sense, the old population whose methods and villages have persisted unchanged for centuries; a few settled nomads on the slopes; and, mostly in the northeast, immigrants from Russia since 1865 and more lately from the Balkans. They appear to have numbered about 2,400 in 1927, of whom about 900 gave Greece as their country of birth. These immigrants have had a very favorable effect upon agriculture in introducing new methods and technical skill—especially in the making of artesian wells. In the second monograph of the series, Charlotte von Trotha narrates the development of rural settlements along the coast near Köslin, Pomerania. Several types of village forms are found here, including the "round." The writer attacks the view that these are solely of Slav origin, seeking to explain their form in relation to their geographical environment. One of the original documents reproduced is a portion of a large-scale map dated 1588.

ELECTIONS TO THE ROYAL SOCIETY OF EDINBURGH

ACCORDING to a report in *Nature* the following were elected fellows of the Royal Society of Edinburgh at the annual stated meeting: Dr. F. L. Arnot, lecturer in natural philosophy in the University of St. Andrews; Major P. C. Banerjee, Indian Medical Service; J. L. Begg, treasurer and past vice-president of the Geological Society of Glasgow; Dr. T. R. Bolam, lecturer in chemistry, University of Edinburgh; Finlay J. Cameron, general manager, Caledonian Insurance Company, Edinburgh; J. I. Carswell, lecturer in engineering, University of Edinburgh; Dr. A. M. Clark, lecturer and director of studies, University of Edinburgh; Dr. A. L. Craig-Bennett, lecturer in zoology, University of Edinburgh; E. G. Dymond, Carnegie research fellow and lecturer in natural philosophy, University of Edinburgh; J. M. Erskine, general manager, Commercial Bank of Scotland, Ltd., Edinburgh; Dr. Thomas Ferguson, medical inspector of factories, Home Office; Professor C. Forrester, department of chemistry and assaying, and acting principal, Indian School of Mines, Dhanbad; Dr. W. H. Fowler, medical radiologist, Edinburgh; A. W. de R. Galbraith, city engineer, architect and surveyor, Christchurch, New Zealand; A. C. Gardner, chief engineer, Clyde Navigation Trust, Glasgow; Dr. R. P. Gillespie, lecturer in mathematics, University of Glasgow; T. H. Gillespie, director-secretary, Zoological Society of Scotland, Edinburgh; W. G. Guthrie, assistant in applied mathematics, University of St. Andrews; Lieutenant-Colonel E. E. Hume, Medical Corps, United States Army, librarian of the Army Medical Library, Washington, D.C.; Dr. D. Lees, clinical medical officer, Corporation of Edinburgh and surgeon in charge of venereal diseases, Royal Infirmary, Edinburgh; J. Macleod, manager, Glasgow Corporation Chemical Department; Professor J. Malcolm, department of physiology, University of Dunedin, New Zealand; W. J. M. Menzies, inspector of salmon fisheries of Scotland, Fishery Board for Scotland, Edinburgh; Professor L. M. Milne-Thomson, assistant professor of mathematics, Royal Naval College, Greenwich; Dr. J. Murray, rector, The Academy, Annan; T. Nicol, lecturer in anatomy, University of Glasgow; C. W. Parsons, lecturer in zoology, University of Glasgow; A. W. N. Pillers, chief veterinary officer, Corporation of Liverpool and lecturer on veterinary parasitology, University of Liverpool Veterinary School; F. A. B. Preston, lecturer in municipal engineering, town planning, etc., Royal Technical College, Glasgow; J. L. Somerville, auditor to the University of Edinburgh; Dr. J. B. Tait, junior naturalist (hydrographer), Fishery Board for Scotland, Aberdeen; G. Taylor, assistant keeper, department of botany, British Museum; Dr. G. Timms, lecturer in mathematics, University of St. Andrews; Professor J. M. Watt, department of pharmacology and lecturer in dental materia medica, University of the Witwatersrand, Johannesburg; Dr. W. F. J. Whitley, medical officer of health, Northumberland County Council; J. Wright, Kirkcaldy.

THE NORTH AMERICAN COUNCIL ON FISHERY INVESTIGATIONS

ON September 13 and 14 the North American Council on Fishery Investigations held its twentieth annual meeting at the Atlantic Biological Station, St. Andrews, New Brunswick. This council is an international body composed of representatives of Canada, Newfoundland, France and the United States, and was organized on invitation of the Canadian Government in 1921 to cooperate in scientific investigations of the deep-sea fisheries adjacent to the North Atlantic coast of the American continent. Since 1928 annual meetings of the council have been held in various cities in Canada and the United States, which have been attended by a growing number of marine fishery investigators concerned with a study of the great fisheries in which each of the member nations is directly concerned. The purpose of these meetings is to correlate the results of investigations in the western Atlantic and to make them mutually available to the several countries involved, thus bringing about by informal arrangements without overhead charges a unity of purpose and a coordination of method in fishery research and a corresponding avoidance of duplication of effort.

The St. Andrews meeting was attended by upwards of twenty-five government and private fishery investigators, and reports of progress were presented covering investigations of the cod, haddock, mackerel, herring and squid fisheries, and hydrographic and biological investigations relating to temperature, currents and the chemical and biological content of the offshore and coastal waters. The question of obtaining uniform and mutually comparable fishery statistics based on the origin of catch as a guide to the proper management of the fisheries was given particular attention.

The United States was officially represented by Dr. H. B. Bigelow, director of the Woods Hole Oceanographic Institution and chairman of the council, and by Elmer Higgins, of the U. S. Bureau of Fisheries. Reports on their respective fishery investigations were presented by O. E. Sette and W. C. Herrington, both of the North Atlantic staff.

THE GEOLOGICAL SOCIETY OF AMERICA AND AFFILIATED SOCIETIES

THE forty-sixth annual meeting of the Geological Society of America will be held Thursday, Friday and

Saturday, December 28, 29 and 30, at Chicago, under the auspices of the University of Chicago, Northwestern University and the Chicago Geological Society.

Headquarters, place of registration and exhibits will be at the Reynolds Club, University of Chicago, 57th Street and University Avenue. The scientific sessions will be held at the University of Chicago.

By order of the council no paper will be considered for the program unless the title is accompanied by an abstract suitable for printing in the proceedings of the society. Abstracts must be in the hands of the secretary before November 25 in order to appear in the preliminary list of papers.

The address of the retiring president, Professor C. K. Leith, on "The Pre-Cambrian" will be delivered on December 28 at 8 P. M. It will be followed by a smoker. The regular dinner of the society will be held on December 29, at 7 P. M., at the Hotel Shoreland.

The secretary of the society is Professor Charles P. Berkey, Columbia University.

The following affiliated societies will meet at the same time and place:

The Paleontological Society, Professor B. F. Howell, Princeton University, *secretary.*

The Mineralogical Society of America, Professor A. B. Peck, University of Michigan, *acting secretary.*

The Society of Economic Geologists, Donald H. McLaughlin, Harvard University, *secretary.*

The Association of American Geographers and the National Council of Geography Teachers will hold meetings at Evanston during the same period.

Section E of the American Association for the Advancement of Science will meet in Boston, Massachusetts, on December 27. The secretary of the section is Kirtley F. Mather, Harvard University.

SCIENTIFIC NOTES AND NEWS

THE Nobel Prize in physiology or medicine, according to an Associated Press dispatch from Stockholm, has been awarded to Dr. Thomas Hunt Morgan, director of the William G. Kerckhoff Laboratories of the California Institute of Technology.

DR. ALBERT EINSTEIN arrived on October 17 to take up his work at the Institute for Advanced Study at Princeton.

DR. KARL LANDSTEINER, member of The Rockefeller Institute for Medical Research, New York, has been elected an honorary fellow of the Royal Society of Medicine, London.

THE Frederic Ives Medal for distinctive work in optics was presented to Dr. R. W. Wood, professor of experimental physics at the Johns Hopkins University, on October 20 at the meeting of the Optical Society of America at Buck Hill Falls, Pennsylvania.

THE honorary degree of doctor of science was conferred on Frederick Webb Hodge, director of the Southwest Museum, Los Angeles, by Pomona College, in connection with its Founders' Day celebration on October 12.

DR. MAX LEDERER, director of the laboratories of the Jewish Hospital of Brooklyn, known especially for his work on infectious hemolytic anemia, will be the guest of honor at a dinner to be tendered to him by the department of pathology of the hospital on October 31.

DR. THOMAS DARLINGTON, health commissioner of New York from 1904 to 1910, celebrated his seventy-fifth birthday on September 24.

LORD IRWIN, president of the British Board of Education, made a presentation, on behalf of the Advisory Council of the Science Museum, on October 11 to Sir Henry Lyons, who recently retired as director after serving for twenty-one years.

DR. OTTO APPEL, formerly director of the Institute of Agriculture and Forestry in Berlin, has been elected an honorary member of the Botanical Union of Thuringia.

PRINCE LUDOVICO SPADA-POTENZIANI was elected president of the International Institute of Agriculture on October 12 at the annual meeting held in Rome. Dr. Henry Charles Taylor, of Washington, D. C., was the American delegate. This is the first time the United States has been represented at the institute since 1929.

AT a preliminary conference in London, to arrange for the second International Neurological Congress, to be held there in August, 1935, Sir Charles S. Sherrington, Oxford, was elected *president;* Dr. Bernard Sachs, New York, *honorary president,* and Dr. Gordon M. Holmes, London, England, *acting president.*

NEW officers elected at the recent meeting of the Optical Society of America are: W. B. Rayton, head of optical design of the Bausch and Lomb Optical Company, *president;* Arthur C. Hardy, associate professor of physics at the Massachusetts Institute of Technology, *vice-president;* H. F. Kurtz, of the Science Bureau of the Bausch and Lomb Optical Company, *treasurer;* Dr. L. B. Tuckerman, assistant chief of the division of mechanics and sound of the Bureau of Standards, Washington, *secretary.*

THE officers of the Yale Chapter of Sigma Xi for this year are as follows: George A. Garratt, associate professor of forest products, *president;* Barnett F. Dodge, associate professor of chemical engineering, *vice-president;* Leon S. Stone, associate professor of anatomy, *secretary,* and Harold H. Walker, instructor in public health, *secretary.*

THE following emeritus professors in residence at Columbia University have been assigned to the faculties in which they had seats when in active service: Philosophy, John Dewey and Edward D. Perry; Political Science, Edwin R. A. Seligman; Pure Science, Edmund B. Wilson and Michael I. Pupin; Columbia College, Edward D. Perry and Edwin R. A. Seligman; Barnard, Edward D. Perry; Engineering, Michael I. Pupin; Journalism, John W. Cunliffe.

FULL professors in German universities have been appointed as follows: Dr. Roland Brinkmann, of Göttingen, professor of geology at Hamburg; Dr. Fritz Sander, of Geissen, professor of experimental psychology at Jena, and Dr. Heinrich Vogt, of Jena, professor of astronomy at Heidelberg.

A DEPARTMENT of bacteriology has been established at the University of Georgia Medical Department. The faculty will include Dr. James A. Kennedy, University of Rochester School of Medicine; Dr. Ferdinand C. Lee, the Johns Hopkins Hospital; James O. Pinkston, Harvard Medical School, and Dr. Marion S. Dooley, Syracuse University College of Medicine.

DR. EDWARD W. BERRY, professor of paleontology at the Johns Hopkins University, was erroneously referred to in a recent note in SCIENCE as "vice-president" instead of as "dean" of the Johns Hopkins University.

AT the expiration of his term as National Research Council fellow at the Johns Hopkins University, Lyman C. Craig received an appointment to the staff of the Rockefeller Institute for Medical Research, New York, where he is assistant in the department of chemical pharmacology.

DR. MONROE H. MARTIN, National Research fellow at Harvard University, has been appointed instructor in mathematics at Trinity College.

ARTHUR L. KIMBALL, research physicist, has been transferred from the staff of the research laboratory of the General Electric Company, Schenectady, New York, to the engineering general department, where he will assist engineering departments of the company on problems involving ventilation, vibration and noise. E. L. Thearle will succeed Mr. Kimball in directing the mechanical research section of the research laboratory.

KENNETH A. CLARK, who has been specialist in animal husbandry for the University of Maryland Extension Service for the last eight years, has resigned to accept the management of a group of farms in Frederick County, Maryland.

DR. E. SCHRÖDINGER, formerly professor of theoretical physics at Berlin, has been given a supernumerary fellowship at the University of Oxford.

DR. B. N. UPPAL, plant pathologist to the Government of Bombay, has been granted a scholarship of £500 by the Imperial Council of Agricultural Research, India, for one year, to study advances in scientific knowledge pertaining to the virus diseases of plants. He will spend six or seven months at the Rothamsted Experimental Station, England, and laboratories on the continent, and about four months in the United States at the Rockefeller Institute for Medical Research, Princeton, New Jersey, and at the University of Wisconsin. After his return to India, Dr. Uppal will direct the scheme on virus diseases of plants sanctioned by the Imperial Council of Agricultural Research at a cost of about $25,000 for a period of five years.

DR. F. TRUBEE DAVISON, president of the American Museum of Natural History, who spent the summer in hunting big game in Africa, has returned to New York.

DR. EARLE B. PERKINS, assistant professor of zoology at Rutgers University, has been granted a two years' leave of absence to join the Byrd Antarctic Expedition as zoologist. He will study especially the protozoa and invertebrates found in the Antarctic regions. Dr. W. Hinckley Mitchell, Jr., will substitute for Dr. Perkins at Rutgers.

DR. KARL T. COMPTON, president of the Massachusetts Institute of Technology, spoke before the New England section of the Society for the Promotion of Engineering Education on "The Engineers' Council for Professional Development," at a meeting at the University of New Hampshire on October 21.

DR. LUTHER L. HILL, Montgomery, formerly president of the Medical Association of the State of Alabama, gave the annual address commemorating the seventy-ninth anniversary of the birth of William Crawford Gorgas before the Lafayette Guild Chapter of the Gorgas Medical Society, University of Alabama, on October 3. His subject was "Medical History." Dr. Hill was made an honorary fellow of the Gorgas Society following the lecture.

DR. ROLLA E. DYER, of the U. S. Public Health Service, Washington, D. C., delivered the first Harvey Lecture of the season at the New York Academy of Medicine, on October 19, on "Typhus and Rocky Mountain Spotted Fever in the United States."

DR. C. A. MILLS, James T. Heady professor of experimental medicine at the University of Cincinnati College of Medicine, addressed the university chapter of Sigma Xi on "Man's Response to Climate," on October 17.

THE New Orleans Academy of Sciences celebrated its eightieth anniversary on Friday, October 13, with a public meeting held in Gibson Hall, Tulane University. A large assembly of members and guests listened to an outline of the history of the academy, which was the first formally affiliated branch of the American Association for the Advancement of Science, presented by Dr. Robert Glenk, president of the academy and curator of the Louisiana State Museum, and to an address on "Science and Progress" by Dr. Edgar Odell Lovett, president of Rice Institute of Texas. The guest speaker was introduced by Dr. H. H. Beard, first vice-president of the academy. Following the address of the evening the academy adopted a revised constitution and by-laws for the organization and a number of important meetings were planned for the winter.

THE New York State College of Forestry at Syracuse reports that the Dutch elm tree disease has recently been found in the New York City district. It has already done considerable damage in Ohio and is well established in New Jersey. The disease is so virulent that it is capable of wiping out the elm tree in the same way as the chestnut blight fungus has succeeded in destroying the chestnut tree. The disease may be detected in several ways but the most evident symptom for the average person to observe is the sudden yellowing and wilting of the leaves. As the leaves will soon fall from the trees, this most evident means of identification will soon disappear. Twigs bearing wilted leaves should be cut open since trees suffering from this malady show brown spots or streaks in the outer sapwood of the branches. Positive identification of the Dutch elm fungus can be made only by microscopic examination of cultures made from the sapwood, however. The U. S. Department of Agriculture has sent Paul V. Mook and Dr. P. Pirone to Westchester County to assist in warding off the disease of trees. They will survey trees on county park property and private estates to determine the extent of the infection.

A COMMUNICATION from *The New York Times* from Chapel Hill, North Carolina, states that a disagreement between the administration of the University of North Carolina and the Medical School over the policy relating to the percentage of Jews to be admitted to the first year medical class has led to the recent resignation of Dr. Isaac H. Manning as dean of the Medical School. Dean Manning had long adhered to a policy of limiting the Jews in the first year class to ten per cent. of the class enrolment, which was forty. He had held that this policy was necessary because of the difficulty in placing Jewish students in the leading medical schools of the country. President Frank Graham held that discrimination by the four-year medical school was no valid reason for discrimination by the university. The quota of four had been filled this fall when a fifth Jewish boy applied for admission. When Dr. Manning refused to meet him, the youth appealed to President Graham, who overruled the dean and admitted the boy on the ground that the university admits any boy properly qualified and not restricted by law. Dean Manning will continue as a member of the faculty.

THE *Journal* of the American Medical Association reports that the German Booksellers Association has taken action concerning the prices of scientific periodicals. The following code of practise was recently agreed on: (1) Publishers of all scientific journals must specify the number of parts or volumes and the annual subscription price before the start of a new volume or publication year and must keep within that limit for the period agreed to. (2) Medical and scientific periodicals now published at inflated prices should be reduced not less than 20 per cent. in price and contents for 1934. (3) The Boersen Verein finds the foregoing points of utmost importance and to ignore them would be to repudiate its obligations to its members. (4) The Association of German Universities expects that publishers, editors and contributors will abide by the specifications in paragraphs 1 and 2 and also will reject any material (especially dissertations) that really should not form part of a journal. (5) Both the Association of German Universities and the Boersen Verein are of the opinion that, through limitation of the contents, the size of the journals will be reduced. Also, the material offered should be more concise and so presented as to increase the value of the journal.

IT is stated in the *British Medical Journal* that the will of the late Lord Leverhulme directed that the income arising from a part of his estate should be devoted to the granting of scholarships to British-born students for "research and education," and the trustees have recently made grants for this purpose to several institutions. They have now resolved to devote from income of the fund a sum of £12,000 a year to the establishment of a scheme of research fellowships. These are intended in the first instance for the assistance of experienced workers. The trustees have in mind particularly men and women who are prevented either by pressure of routine duties or by any other cause from undertaking or completing an investigation of value. They have decided, therefore, to place no definite limit to the amount of individual

grants, which will be adjusted according to the circumstances of each case. The duration of grants will normally not exceed two years. Fellows will usually be required to work at or in connection with a recognized center of research, either at home or abroad. The following have accepted their invitation to serve on an advisory committee for the selection of fellows and for the general supervision of the scheme: Dr. H. J. W. Hetherington (chairman), Professor A. M. Carr-Saunders, Sir William Hardy, F.R.S., Dr. N. V. Sidgwick, F.R.S., and Mr. H. T. Tizard, F.R.S. Dr. L. Haden Guest has been appointed secretary.

DISCUSSION

HONOR BESTOWED ON DR. DAVID EUGENE SMITH BY THE SHAH OF PERSIA

To the many friends, colleagues and former students of Dr. David Eugene Smith, professor emeritus of mathematics, Columbia University, it will be interesting to know of the appropriate and appreciative recognition recently bestowed on him by H. I. Majesty, the Shah of Persia.

During an absence of four months last winter and spring, spent chiefly in Persia, Iraq and Syria, Dr. Smith traveled by motor upwards of 10,000 kilometers from the time he left Haifa until he reached Turkey. He secured more than 150 manuscripts—mostly Persian, Arabic and Hebrew. Among them were several mathematical pieces of importance, chiefly Arabic translations from the Greek classics, together with a 14th century manuscript of Omar Khayyám's algebra. The translations from the Greek include two Euclids, Archimedes on the circle, and Aristarchus on astronomy. Also he supplemented his early 19th century manuscript of Ulug Begh's tables by three other earlier sets. In the lot were commentaries on al-Khowārizmī's algebra and Beha Eddin's arithmetic.

His collection, which contains also manuscripts of works on the Persian poets, he enlarged by copies, usually with miniatures, of the classics of Ferdousi, Hafiz, Sa'di, Omar Khayyám, Nazāmī, Omar ibn Ghares and others. His large library of Korans and Koranic literature, a few specimens of which are now in the Islamic exhibition in the Metropolitan Museum (New York), was greatly enriched by about 100 additional manuscripts, several with unusually fine decorations and bindings. These acquisitions will form part of his personal library of over 20,000 items which he has presented to the library of Columbia University (the educational works to the special library of Teachers College).

It is well known that mathematical scholarship has a correlation with musical interpretation and appreciation, but seldom with poetical temperament and metrical construction.

In appreciation of Dr. Smith's new metrical version of Omar Khayyám's "Rubáiyát" in 289 quatrains, which was the first work to be worthily illustrated by a Persian artist of high standing, and in recognition of his interest in the mathematical achievements of the country, the Persian Government conferred upon him, in the presence of a distinguished audience, the gold star of the Order of Elim, decoration of the first rank. After an address by Professor Smith, who was introduced by H. Highness Feroughi, Minister of Foreign Affairs, the presentation was made by H. Highness Esfandiari, the oldest of the former ministers of state. The addresses upon the occasion were published in full in the Persian papers, in some cases with an English summary. An autographed portrait of H. I. Majesty, the Shah, was also among the highly prized souvenirs which were presented to him. He gave addresses in several of the cities and visited a number of the important excavations now in progress in Syria, Iraq and Persia.

Since his retirement from Columbia University, Dr. Smith has profitably engaged in accumulating a unique collection of books, manuscripts, letters and portrait prints of great value to the history of science, and more particularly of value to the history of mathematics. This is to-day probably the most outstanding collection of its kind gathered together by a single individual.

FREDERICK E. BRASCH

LIBRARY OF CONGRESS
WASHINGTON, D. C.

EXPEDITIONS

IN the current number of *Natural History*, Mr. James L. Clark has a very instructive article on "Expeditions," in which he gives advice to those who contemplate journeys abroad for scientific purposes. While thoroughly appreciating the wisdom and experience represented by this article, I refer to it now for the purpose of emphasizing some points which are, it seems, not generally appreciated. Mr. Clark says: "Expeditions are necessarily expensive," and goes on to discuss how they may be financed. He himself has been chiefly interested in securing specimens of the larger mammals, but of course these constitute only a very small part of the fauna. It should be emphatically stated, at the present time, that expeditions to many places and for many purposes require only moderate funds, and that there is no direct relation between the amount of money expended and the scientific results. The world has greatly changed in these respects within my memory. As a

boy, I used to look with wonder and curiosity at the large blank spaces on the map of Africa. I was quite old enough to have been present at the discovery of Lake Kivu, had I been exploring Africa at that time. These regions were either inaccessible, or were only reached at the cost of much time, labor and money, with some risk to life. Now we go with comfort and speed, and the cost is quite moderate. But the fauna and flora are still there, excepting only some of the larger animals which have been decimated or exterminated by hunters. It is true that many of the more interesting discoveries have already been made and recorded, but the wealth of novelties still remaining is almost beyond belief. Field observations on the habits of many groups of invertebrates have scarcely more than begun. It does not in the least detract from the scientific results of an expedition that it is far easier and cheaper than formerly; on the contrary, the harvest is likely to be greater and more valuable, because the conditions are better.

As Mr Clark rightly insists, there should always be "definite purposes and objectives." Those who have no such purposes rarely accomplish much of value. Nevertheless, it is important to be prepared for the unexpected. I am constantly asked, when about to start on an expedition, "What do you expect to find?" I often answer, "I expect to find what I do not expect to find," a seeming paradox explained by referring to the enormous complexity of nature and the innumerable surprises it affords.

Thus it appears that amateurs, without very much training or large resources, can do important work for science. They can also get a great deal of pleasure and interest for themselves, and may take a justifiable pride in the results. It is necessary, however, to get the materials worked up and the results published. Collectors must be content, as things now are, if by far the greater part of their collections reposes on the shelves of museums, awaiting the touch of a posterity perhaps not yet born. I have had occasion to describe bees collected on the famous voyage of the *Beagle*. But it is often possible to find specialists who will more or less promptly attend to the groups they are interested in, so that the members of an expedition will not have to wait too long to ascertain whether they were successful. Better organization is needed in respect to these matters. Thus, it would seem worth while for any large museum to issue a circular or pamphlet, setting forth the desiderata which could be dealt with promptly. Yet even in the case of groups which find no students, an active worker may appear at any time and utilize all that has been gathered up to date.

One thing reacts on another. If there were more amateurs, anxious to collect scientific materials and study them, as far as their training and circumstances might permit, there would be more interest in and support for the specialists whose cooperation is needed. There would be better chances for publication, and books would begin to appear, which would make many matters intelligible to those having a reasonable amount of scientific curiosity. The general result would be an increase in the cultural level of the people, something sorely needed at the present time.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO
BOULDER

ALFALFA YELLOWS

BECAUSE the extent of the injury sustained by agronomic plants from insects is governed by a complex of factors involving environmental reactions of the host plants and their relations to the habits and populations of the parasites, there are, at times, simple agronomic procedures that prove to be effective remedies. Such is the case with the stunting and yellowing of alfalfa that is caused, primarily, by leafhoppers (*Empoasca fabae*). In Wisconsin this injury appears primarily in the second growth, and that it is definitely associated with increased populations, resulting from early cutting of the first crop, is made clearly evident by cutting trials of alfalfa and population counts of leafhoppers during the past two years.

Since leafhoppers do not usually appear in alfalfa fields in large numbers until the plants are near blossoming, their injury is not, as a rule, of great importance with the first cutting of hay. When this cutting is deferred until the field shows abundant blossoming the adults will have laid in the green tissues of the alfalfa the major portion of the eggs of this brood. Such eggs are removed in the first crop of hay before they hatch into nymphs, thus greatly reducing the populations in the second growth. With earlier cuttings of the first crop, egg deposition, not being completed, is continued by surviving and migrating adults, often resulting in large populations of nymphs, which in specific trials this past season reduced the productivity of the second growth of alfalfa from 66 to 75 per cent. Thus, cutting one half of each plat of a series on June 9 resulted in a stunted yellow growth of the second crop in which, on July 15, there were present 29 times as many nymphs as were found in the healthy growth of alfalfa in the adjacent areas where the first crop was removed on June 21. Since these nymphs are relatively static and do not begin to migrate until they have approached the adult stage, alfalfa prevailed in adjacent areas of the second clear-cut contrasts of short yellow and tall green

growth with only twelve days difference in the time of cutting the first crop. A few days prior to the cutting of the second growth on July 31 the nymphs had largely become adults and through migration caused a yellowing of all the alfalfa. However, they disappeared rapidly after this cutting. It does not appear that conditions are favorable for their propagation during the period of the third growth—at least, this crop is rarely injured seriously by them in Wisconsin.

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CONJUGATION IN RHIZOPUS INHIBITED BY FEMALE SEX HORMONE

ALTHOUGH the female sex hormone has been isolated from various plant tissues, the authors have been unable to find any reference to experiments as to its effect on plants.

For a preliminary test of the effect of estrin on plants, *Rhizopus nigricans* was selected because of its rapidity of growth and conjugation. Estrin used in this work was prepared from human pregnancy urine by R. G. Gustavson and his coworkers at Denver University. Parke, Davis' commercial theelin preparation was also used.

All cultures were grown on standard potato dextrose agar, in petri dishes. The agar substrate was divided into two parts by a groove about an eighth of an inch wide. One side of the plate was inoculated with + strain of *R. nigricans* and the other side with − strain.

An initial concentration of about 5 Coward-Burns rat units of estrin incorporated in the agar was found to be more satisfactory. In some cases, estrin was added after the colonies had begun to grow. A total of over 300 cultures have been studied in the several tests and in every case the estrin or female hormone inhibited zygospore formation, while accompanying untreated check cultures conjugated profusely. With the initial treatment the formation of gametangia was delayed from four to six hours. With continued dosage the sexual fusion was delayed for longer periods of time. The same effect was observed in the case of theelin.

The results of these experiments are comparable to those of D'Amour and others, who found that estrin terminates pregnancy in rats. Agreement with his work was also found in that one Coward-Burns unit is the equivalent of about 12 Allen and Doisy units.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN ELECTRICALLY DRIVEN CONTACT BREAKER CAPABLE OF DELIVERING GALVANIC SHOCKS RANGING FROM 0.000,01 TO 1.0 SECOND DURATION

THIS contact breaker, designed primarily for research, has been used in the student laboratory for several years in a class experiment on the correlation of duration and strength of galvanic stimulation. Its ruggedness and dependability for student and research purposes, its convenience of manipulation and long range of shocks may be of interest to those contemplating a similar device.

The construction is simple and most of the details are apparent in Fig. 1. It consists of two essential parts—a heavy iron flywheel carrying a knock-over and an automatically advancing carriage for moving the knock-over keys into the path of the knock-over.

The flywheel (7.5 cm × 21 cm) is revolved at a rate of 1,200 r.p.m. by a lead screw serving as a connecting shaft to the motor. The employment of a synchronous motor and a heavy and well-balanced wheel and motor insures a uniform velocity of movement of the knock-over. Note that a dummy knock-over is mounted in the opposite face and circumference of the wheel.

Two keys are mounted on the carriage. The key at the left is for coarse adjustment of 0.05 of a second intervals. By separating the keys 20 scale divisions (each division is equivalent to 1 thread of the lead screw), the maximum interval of 1 second is attained. The key at the right is mounted on a disk, also 21 cm circumference graduated into 500 equal parts. This disk is in turn attached to a heavy vertical support fixed to the horizontal bar and sliding in a snugly fitting way in the supporting base. A vernier permits setting of the keys at intervals of 0.000,01 second.

The carriage is operated by a swinging quarter nut clutch which is thrust into position as the motor is turning. Just as the clutch is completely engaged, a spring operated latch pops out of the free end of the clutch to the inside of a guiding bar and keeps the clutch engaged for the entire excursion (Fig. 2). Towards the end of the excursion it passes between the guiding bar and another bar mounted on a steel spring, and as it clears the guiding bar it is thrust

FIGURE 1

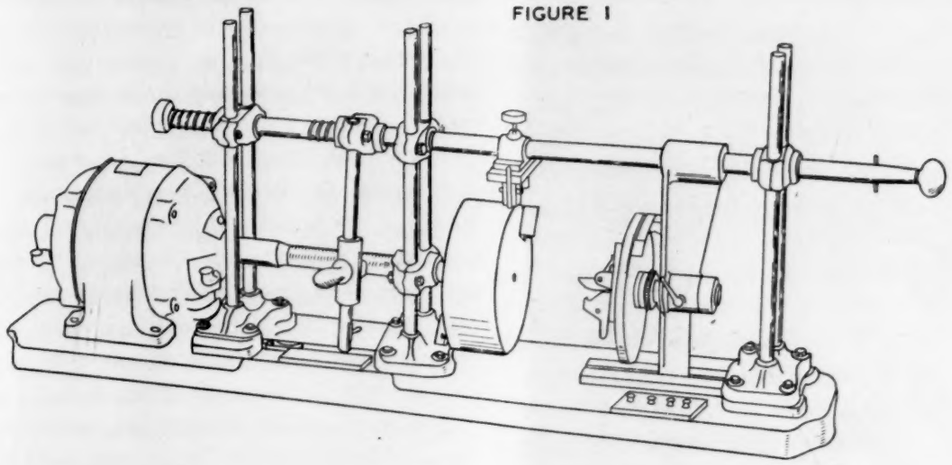

FIGURE 2

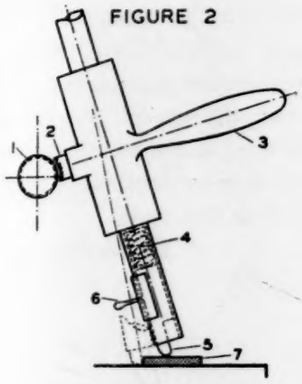

FIGURE 3

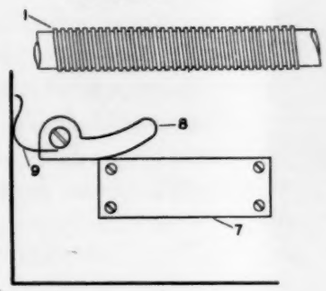

FIGURE 4

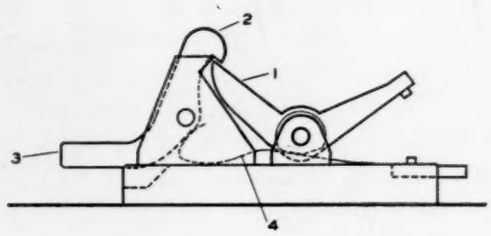

FIG. 1. Contact breaker.

FIG. 2. Arrangement for maintaining engagement of clutch. (1) Lead screw. (2) Quarter nut clutch. (3) Handle for manipulating clutch. (4) Spring to force out latch. (5) Latch. (6) Handle for shifting latch to release the clutch. (7) Guiding bar used to keep clutch engaged.

FIG. 3. Arrangement for automatically releasing clutch at the end of excursion. (1) Lead screw. (7) Guiding bar. (8) Clutch disengaging device. (9) Steel spring operating clutch disengaging device.

FIG. 4. Knock-over key. (1) Arm engaging with knock-over. (2) Catch preventing rebound of key. (3) Arm used to release catch. (4) Steel spring operating catch 2.

outward by the spring, thereby automatically releasing the clutch. This mechanism is detailed in Fig. 3.

The keys are so arranged that when number one is at the zero mark on the carriage arm and number 2 on the zero mark on the disk they are adjacent and open simultaneously. To deliver a shock, *e.g.*, of 0.025 seconds the disks must be turned clockwise 180° or 250 scale division. Since that position requires an additional half turn of the flywheel and lead screw for the knock-over and key to engage, key 2 would advance one half of a thread further than that required to meet the knock-over key. To overcome the resulting difficulty and to attain a uniform engagement of key 2 and the knock-over with any setting of the scale, the disk is mounted on a lead screw similar to the driving shaft. For zero setting the lead screw and disk is opened one complete turn. When key 2 is now set for 0.025 second at the 250th scale division the disk is turned clockwise, advancing it one half of a thread to the right. This insures precisely the same engagement of knock-over and key as at zero setting.

The impact of the knock-over is of sufficient force (velocity 13 meters per second) to require careful hardening of both the knock-over and the key and special arrangements preventing rebound of the keys. The keys are detailed in Fig. 4.

Calibration by the condenser method for the shorter interval settings of the instrument indicate an accuracy of about 0.000,025 seconds.

I am obliged to Dr. Bean, who is conducting experiments on chronaxie with this device for the calibration.

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A TILTING BLACKBOARD FOR GEOLOGIC INSTRUCTION

PERSONS accustomed to geologic profiles and structure sections can readily imagine them tilted this way or that on the blackboard or on paper. In other words, they can readily imagine the horizontal of the drawing to be something other than the horizontal of the blackboard or the paper. Beginning students find this difficult, and some help is desirable in introducing the general concept of tilting to classes in geology.

In my classroom is a light, auxiliary blackboard about 18 inches high and 48 inches long. The writing surface is of special blackboard paint on very dense, thin wallboard made of wood fiber compacted under unusually great pressure. A frame of fir, of $\frac{7}{8}$ by $2\frac{1}{2}$ inch cross-section, gives adequate stiffness to the whole. Rubber-covered nails, driven into the back of the fir frame, protect the permanent, main blackboard. Both ends of a slack cord are attached to screw-eyes in the upper edge of the frame. The cord is passed over two hooks in the upper molding of the permanent blackboard. By sliding the cord over the hooks the auxiliary blackboard may be hung horizontally or may be tilted either way.

The simplest and yet the most valuable use to which I have put it is in explaining unconformities. The auxiliary blackboard is placed so its long axis is horizontal, and half a dozen horizontal lines are drawn on it to represent the deposition of some horizontal strata. Then the board is tilted and erasure above a new horizontal line represents erosion to a new horizontal surface that bevels the tilted strata. Addition of a new set of horizontal strata gives an angular unconformity. Overlaps, both transgressive and regressive, may be illustrated readily. A cross-section of a lake may be tilted, bringing wave-made features above the water on one side of the lake and submerging them on the other side.

The auxiliary blackboard is also convenient on quiz days. The first question or two may be written on the blackboard in the office beforehand. As soon as the paper is distributed and the blackboard hung up the students can get to work. There is no delay while the instructor writes the questions.

It happened that our university carpenter shop had suitable scrap material, so the cost to my department was nil. I judge that new material would cost a dollar or at the most two dollars.

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SPECIAL ARTICLES

EVAPORATION, TRANSPIRATION AND OXYGEN CONSUMPTION BY ROOTS[1]

EARLIER experiments by one of us showed that, other factors being equal, the rate of oxygen absorption by roots might be less when the shoot is in light than when it is in shade or darkness.[2] The experiments here summarized support the earlier conclusion and suggest certain possible causes for exceptions.

In the present experiments the most important conditions were the following, namely, the plants were in distilled water during the tests, but were kept otherwise in a normal culture solution, and the shoots were either in dense shade, or darkness, or were directly exposed to sunlight. The temperature of the solution was fairly constant. The evaporating power of the air was determined with white and black atmometers. The oxygen determinations were made with the Thompson-Miller apparatus and by the Winkler method. The plants used were cuttings of willow (*Salix laevigata* Bebb, from Stanford University, and *S. exigua* Nuttall, from San Diego). The experiments were carried out in the summer at Stanford University. The leading results can be briefly presented, as follows:

When the shoots were kept in dense shade, or darkness, for one hour, as from 8 to 9, or from 9 to 10 A. M., and immediately thereafter placed in direct sunlight for one hour, the consumption of oxygen by the root was usually less during the period of light.

The evaporating power of the air was always greater during the light period, but it varied from day to day. Especially the ratio of black to white atmometer readings (B/W) were found to range from 1.5 to 1.9, which was in part the result of haziness, from whatever cause, often obtaining in early morning. Although further work must be done to surely establish the relation, it was apparent from the experiments that a high ratio would be expected to be coincident with low oxygen consumption of the roots, other factors being equal, and that the converse would be expected with a low ratio. This, it will be seen, is merely a means of defining in a certain way the light-oxygen-consumption relation of the root.

Quite as important a factor is that of the temperature of the culture. When the temperature was low, as about 16° C., the oxygen consumption was also low, whatever the light conditions may have been. But the converse did not appear to follow necessarily.

[1] The investigation was carried out in part with the aid of a grant from the National Research Council.

[2] SCIENCE, n. s., 75: 1934, 108, 1932. *Plant Physiology*, 4: 673, 1932.

At high temperatures, as, for instance, at 29° C., the rate of consumption was also high when the shoot was in darkness, but whether relatively rapid or not, the expected drop in rate took place during the first hour in light (following the hour of darkness). The high temperature, therefore, did not swamp the expected reaction during the light period.

As would be expected, the rate of transpiration was found to be greater during the exposure to sunlight than during the dark period. The ratio between the two (TL/TD) was found to be as much as 44:1. It is apparent, therefore, that a rapid rate of transpiration during the light period does not inhibit the fall of oxygen consumption of the root.

From what has been said it will be seen that the rate of oxygen consumption by the root of willow is indirectly affected by the light relations of the shoot, and may be directly affected by the temperature of the solution. There does not appear to be a positive relation between transpiration rate and that of oxygen absorption by the root. There may be a direct relation between the evaporating power of the air, as revealed by the B/W atmometer readings, and the rate of oxygen consumption. Whether, on the other hand, a high evaporation rate, in the willow at least, influences oxygen absorption by the root remains to be shown.

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SPROUTING AND GRAFTING FRACTIONAL PARTS OF AVOCADO EMBRYOS WITH ATTACHED COTYLEDONOUS MATERIAL

(1) SPROUTING OR GERMINATION

GROWTH responses following splitting in approximately equal parts of the avocado embryo, *Persea americana, P. drymifolia,* either before or after it has sprouted, and planting these fractions with attached cotyledonous material in a sawdust sprouting medium are of general scientific interest. Usually when the whole seed is planted, one sprout from the embryo takes the lead and dwarfs any secondary multiple sprouts which as a rule do not show above the ground. However, when the embryo was split into two fractions and these planted separately with attached cotyledonous material, in many cases, more than one sprout developed from each of the fractional parts of the embryo. These multiple sprouts were in many cases of equal strength. In some cases as many as eight sprouts were observed. It was desirable in the case of multiple sprouting to prune out all but one in order to secure in a reasonable length of time a plant suitable for budding. One-fourth embryos also sprouted and grew. These were secured by splitting half embryos, with cotyledonous material attached, into two portions. The application of this principle makes it possible to secure two or more plants from each avocado seed. An experiment to determine the relative vigor of plants from whole seeds and fractional embryos with attached cotyledonous material is now in progress.

(2) FRACTIONAL EMBRYO GRAFTING

The method of avocado propagation here briefly described is of general scientific interest in that it makes use of the principle of grafting a cion into either the sprouted or unsprouted fractional embryo. The seed is split in two, as reported above, and the cion is then wedge grafted into the fractional embryo with attached cotyledon at any of the three desired developmental stages: (*a*) immediately after splitting the unsprouted embryo; (*b*) after halves planted in sawdust just begin root and plumule elongation; (*c*) after the development of the fractional units has progressed still further—the root is 3 inches or more, and the plumule ½ to 1 inch or more, in length. In the last-named case, the plumule is cut back to point of union with the cotyledon. In a fourth method the whole seed is sprouted and then the developing embryo, including the plumule and tap-root which have reached the stage as indicated under (*c*) above, is split in half and each portion or split plumule is cut back to the point of union of the cotyledon and then grafted. The relative effectiveness of the four procedures has not been fully determined. After all the exposed cut surfaces are waxed with paraffin the completed grafts are placed horizontally with grafted embryo fraction on top, in a propagating medium, covered to a moderate depth (1½ to 2 inches) set in partial sunlight to provide solar heat, and watered liberally. When vigorous sprouts appear on the cion and additional roots have developed, the time varying with different experimental conditions, the grafts are transferred either to standard 12 by 6 by 6 inch cypress plant boxes or planted in the nursery row. When planted deeply, cion roots are formed in many cases.

The anatomy of the graft union and the physiology of growth are being studied. The chief difference between this and other methods of propagating the avocado, *Persea americana, P. drymifolia,* consists in grafting a cion into the sprouted or unsprouted fractional embryo at point of union with cotyledon, and not higher up into the developing plumule or stem. In this method the cion actually takes the place of the developing plumule. Possible advantages are bench operation in propagating, securing double the number of plants from the same number of available seeds and the production of satisfactory nursery trees

in a shorter time than by the usual shield budding method. A complete report will be published later.

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NEW DATA ON THE DEEP SEA FISH STYLOPHTHALMUS AND IDIACANTHUS

IN the course of intensive study of the Stomiatoid fish taken by the Tropical Research Oceanographic Expeditions of the New York Zoological Society off Nonsuch Island, Bermuda, we have come across several interesting facts well worthy of immediate record. These have to do with two families, *Stylophthalmidae* and *Idiacanthidae*. The former was erected by Brauer in 1906 to contain a single genus and species, since which time a number of uncertain forms have been described. The latter family was founded by Peters in 1876 and now contains a single genus and about five species.

In the course of 1,350 nets hauled in an eight-mile circle with its center at 32° 12′ No. Lat. and 64° 36′ West Long., nine and a quarter miles south-southeast of Nonsuch, Bermuda, we have taken 28 specimens of so-called *Stylophthalmus paradoxus* and 101 *Idiacanthus fasciola*. Four fifths of the very young stylophthalmine larvae were taken in a single haul at 100 fathoms, while all older stages came up from between 500 and 1,000 fathoms.

Recent study of these has led me to the following revision of the growth stages of both groups:

Stylophthalmus paradoxus represents the larva and post-larva of *Idiacanthus fasciola*, while the so-called post-larval stages of *I. fasciola*, characterized by enormous post-orbital light organs and the absence of pelvic fins and mental barbels, are in reality diminutive, larvoid, but sexually mature males. These males present extreme lengths of 32 to 45 mm, while the adult females in my collection measure from 60 to 270 mm. The numerical proportion of these dissimilar males and females is four to one.

In the collection of 129 individuals of this species there is represented every intermediate stage between stalk-eyed larvae from 16 to 45 mm, and sexually mature males and females, the latter up to 270 mm in length.

In addition to the above I have taken a number of short-stalked larvae, very similar to those assigned to *Stylophthalmus* by Brauer, which I refer without hesitation to *Argentinidae*, genus *Bathylagus*. Details of the transition from so-called *Stylophthalmus* to *Idiacanthus* will be presented in the course of the monographic treatment of the deep sea fish in the New York Zoological Society's *Zoologica*.

To summarize in brief, the optic nerve which runs the length of the enormously elongated eye-stalk of the larvae is gradually absorbed into the head, pulling the eye with it, more rapidly than the cartilaginous support of the stalk. This cartilage, while still attached to the eye-ball, is bowed down in an ever-tightening spiral, into a pre-ocular socket behind the nares. In this position the tight coil of cartilage is gradually covered with skin, and by late adolescence in both sexes is completely absorbed.

In conclusion, the chief differential characteristics of adult *Idiacanthus fasciola* of both sexes are as follows:

ADULT FEMALES	ADULT MALES
Color, brownish black	Color, dark brown or paler
No subdermal pigment spots	Subdermal pigment, as in larvae
Large fangs	Edentulous
Well-developed pelvic fins	No paired fins
Small postorbital light	Huge postorbital light
Well-developed mental barbel	No barbel
Well-ossified skeleton	Skeleton cartilaginous
Normal, black stomach	Digestive system quite degenerate
Normal ovaries	Testes enormous, occupying most of body.

In addition, the males have an external, apparently copulatory organ, equal in length to the diameter of the eye, and supported by the hollowed, specialized first anal ray.

WILLIAM BEEBE

NONSUCH, BERMUDA

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